Federal Aviation Administration – Regulations and Policies
Aviation Rulemaking Advisory Committee

Transport Airplane and Engine Issue Area
Engine Harmonization Working Group

Task 18 – Critical Parts Integrity Rule Initiative

Task Assignment

[Federal Register: November 7, 2001 (Volume 66, Number 216)]
[Notices]
[Page 56366-56367]
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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Aviation Rulemaking Advisory Committee; Transport Airplane and Engine Issues--New Task

AGENCY: Federal Aviation Administration (**FAA**), DOT.

ACTION: Notice of new task assignment for the Aviation Rulemaking Advisory Committee (ARAC).

SUMMARY: The **FAA** assigned the Aviation Rulemaking Advisory Committee a new task to review and evaluate the current standards for Sec. 33.14 and corresponding JAR-E 515 as they pertain to the current ``safe life'' process. This notice is to inform the public of this ARAC activity.

FOR FURTHER INFORMATION CONTACT: Timoleon Mouzakis, Federal Aviation Administration, New England Region Headquarters, Engine and Propeller Standards Staff, 12 New England Executive Park, Burlington, MA 01803, phone (781) 238-7114, facsimile: (781) 238-7199, timoleon.mouzakis@**faa**.gov.

SUPPLEMENTARY INFORMATION:

Background

The **FAA** established the Aviation Rulemaking Advisory Committee to provide advice and recommendations to the **FAA** Administrator on the **FAA**'s rulemaking activities with respect to aviation-related issues. This includes obtaining advice and recommendations on the **FAA**'s commitments to harmonize Title 14 of the Code of Federal Regulations (14 CFR) with its partners in Europe and Canada.

The Task

1. Review and evaluate the current standards for Sec. 33.14 and corresponding JAR-E-515 as they pertain to the current ``safe life'' process. As the existing standards do not explicitly account for the potential degrading effects of anomalous materials and manufacturing or usage induced anomalies, determine if the **FAA** can expand the current requirement to include damage tolerance philosophies. Also, establish

the process to achieve a closed loop system which links the assumptions made in design (by engineering) to how the part is manufactured and maintained in service.

2. Develop a report based on the review, which may include revisions to the rules. If revisions to the rules are recommended, the report should include recommended regulatory language to the appropriate FAR section, the corresponding JAR paragraphs, any related advisory material, and ARAC's response to the economic questions attached to this tasking record.

3. If, as a result of the recommendations, the **FAA** publishes an NPRM and/or notice of proposed availability of draft advisory circular for public comment, the **FAA** may ask ARAC to review all comments and provide the agency a recommendation for the disposition of those comments.

Schedule: Required completion is no later than September 2003.

ARAC Acceptance of Task

ARAC accepted the task and assigned the task to the Engine Harmonization Working Group, Transport Airplane and Engine Issues. The working group serves as staff to ARAC and assists in the analysis of assigned tasks. ARAC must review and approve the working group's recommendations. If ARAC accepts the working group's recommendations, it will forward them to the **FAA**.

Working Group Activity

The Engine Harmonization Working Group is expected to comply with the procedures adopted by ARAC. As part of the procedures, the working group is expected to:

1. Recommend a work plan for completion of the task, including the rationale supporting such a plan for consideration at the next meeting of the ARAC on transport airplane and engine issues held following publication of this notice.

2. Give a detailed conceptual presentation of the proposed recommendations prior to proceeding with the work stated in item 3 below.

3. Draft the appropriate documents and required analyses and/or any other related materials or documents.

4. Provide a status report at each meeting of the ARAC held to consider transport airplane and engine issues.

Participation in the Working Group

The Engine Harmonization Working Group is composed of technical experts having an interest in the assigned task. A working group member need not be a representative or a member of the full committee.

An individual who has expertise in the subject matter and wishes to become a member of the working group should write to the person listed under the caption FOR FURTHER INFORMATION CONTACT expressing that desire, describing his or her interest in the task, and stating the expertise he or she would bring to the working group. All requests to participate must be received no later than December 7, 2001. The requests will be reviewed by the assistant chair, the assistant executive director, and the working group co-chairs. Individuals will be advised whether or not their request can be accommodated.

Individuals chosen for membership on the working group must represent their aviation community segment and actively participate in the working group (e.g., attend all meetings, provide written comments when requested to do so, etc.). They must devote the resources necessary to support the working group in meeting any assigned deadlines. Members must keep their management chain and those they may represent advised of working group activities and decisions to ensure that the proposed technical solutions do not conflict with their sponsoring organization's position when the subject being negotiated is presented to ARAC for approval.

Once the working group has begun deliberations, members will not be added or substituted without the approval of the assistant chair, the assistant executive director, and the working group co-chairs.

The Secretary of Transportation determined that the formation and use of the ARAC is necessary and in the public interest in connection with the performance of duties imposed on the **FAA** by law.

Meetings of the ARAC will be open to the public. Meetings of the Engine Harmonization Working Group will not be open to the public, except to the extent that individuals with an interest and expertise are selected to participate. The **FAA** will make no public announcement of working group meetings.

Issued in Washington, DC, on October 30, 2001.

Anthony F. Fazio,
Executive Director, Aviation Rulemaking Advisory Committee.

[FR Doc. 01-27998 Filed 11-6-01; 8:45 am]
BILLING CODE 4910-13-M

Recommendation Letter

Pratt & Whitney
400 Main Street
East Hartford, CT 06108

Pratt & Whitney
A United Technologies Company

May 30, 2003

Federal Aviation Administration
800 Independence Avenue, SW
Washington, D.C. 20591

Attention: Mr. Nicholas Sabatini, Associate Administrator for Regulation and Certification

Subject: ARAC Recommendation, Engine Critical Parts Requirements

Reference: ARAC Tasking, Federal Register, November 7, 2001

Dear Nick,

The Transport Airplane and Engine Issues Group is pleased to submit the following as a recommendation to the FAA in accordance with the reference tasking. This information has been prepared by the Engine Harmonization Working Group.

- Proposed NPRM – Aircraft Engine Standards for Engine Critical Parts
- Proposed Advisory Material – Engine Critical Parts Requirements of 14 CFR 33.14

Sincerely yours,

Craig R. Bolt

C. R. Bolt
Assistant Chair, TAEIG

Copy: Dionne Krebs – FAA-NWR
Mike Kaszycki – FAA-NWR
Effie Upshaw – FAA-Washington, D.C.
Jerry McRoberts – Rolls Royce
Marc Bouthillier – FAA-NER
Judith Watson – FAA-NER

Acknowledgement Letter

U.S. Department of Transportation
Federal Aviation Administration

800 Independence Ave., S.W.
Washington, D.C. 20591

SEP 15 2003

Mr. Craig R. Bolt
Assistant Chair, Aviation Rulemaking
Advisory Committee
Pratt & Whitney
400 Main Street, Mail Stop 162-14
East Hartford, CT 06108

Dear Mr. Bolt:

This letter acknowledges receipt of several letters that you sent recently for the Aviation Rulemaking Advisory Committee (ARAC) on Transport Airplane and Engine Issues.

Date of Letter	Task No.	Description of Recommendation	Working Group
05/30/2003	21	Working group reports on landing descent velocity, ground loads, and towing loads	Loads & Dynamics Harmonization Working Group (HWG)
05/30/2003	18	Notice of Proposed rulemaking and advisory material addressing aircraft engine standards for engine critical parts	Engine HWG
06/02/03	1	Working group report on design for security, proposed advisory circular on passenger cabin smoke evacuation, and notice of proposed rulemaking on security related considerations in the design and operation of transport category airplanes	Design for Security HWG

I wish to thank the Aviation Rulemaking Advisory Committee (ARAC) and the working groups for the resources that industry gave to develop these recommendations. Since we consider submittal of the recommendations as completion of the tasks, we have "closed" the tasks and placed the recommendations on the ARAC website at **http://www1.faa.gov/avr/arm/aractasks.cfm?nav=6**. My office has forwarded the Loads and Dynamics and Design for Security HWG's recommendations to the Transport Airplane Directorate, and the Engine HWG recommendations to the Engine and Propeller Directorate.

We will continue to keep you apprised of our efforts on the ARAC recommendations and the rulemaking prioritization at the regular ARAC meetings.

Sincerely,

Margaret Gilligan

Nicholas A. Sabatini
Associate Administrator for Regulation
and Certification

Recommendation

Critical Parts Integrity; Rule Initiative Recommendation

View of All Parts
(Use the text for type of document as a link.)

Draft Advisory Circular – Engine Critical Parts Requirements of 14 CFR 33.14

Draft Notice of proposed rulemaking -- Airworthiness Standards; Aircraft Engine

Standards for Engine Critical Parts

U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Engine Critical Parts Requirements of 14 CFR 33.14.

Date: January 22, 2003
Initiated By: ANE-110

AC No: 33.14-0
Change:

1. **PURPOSE**.
This Advisory Circular (AC) provides definitions, guidance, and acceptable methods, but not the only methods, which may be used to demonstrate compliance with the engine critical parts integrity requirements of part 33, §33.14, of the Federal Aviation Regulations Title 14, Code of Federal Regulations. Section 33.14 contains requirements applicable to the design and life management of engine critical parts.

2. RELATED REGULATIONS

a. Section 33.4, Instructions for Continued Airworthiness.
b. Section 33.15, Materials
c. Section 33.19, Durability
d. Section 33.75, Safety Analysis

3. RELATED READING MATERIAL

a. AC 33.2B Aircraft Engine Type Certification Handbook, dated June 30, 1993
b. AC 33.3 Turbine and Compressor Rotor Type Certification. Substantiation Procedures dated September 9, 1968.
c. AC 33.4-1 Instructions for Continued Airworthiness dated September 11, 1980.
d. AC 33.4-2 Instructions for Continued Airworthiness: In-service Inspection of Safety Critical Turbine Engine Parts at Piece-Part Opportunity, dated March 8, 2001.
e. AC 33.14-1 Damage Tolerance for High Energy Turbine Engine Rotors, dated January 8, 2001.

4. DEFINITIONS.
For the purpose of this AC the following definitions apply.

(a) Approved Life: The mandatory replacement life of a part, which is approved by the Administrator and is listed in the Airworthiness Limitation Section (ALS) of the Instructions for Continued Airworthiness (ICA).

(b) Attributes: Are inherent characteristics of a finished part that determine its capability.

(c) Damage Tolerance: An element of the life management process that recognizes the potential existence of component imperfections. The potential existence of component imperfections is the result of inherent material structure, material processing, component design, manufacturing or usage. Damage tolerance addresses this situation through the incorporation of fracture resistant design, fracture mechanics, process control, or nondestructive inspection.

(d) Engine Critical Parts: Are those parts that rely upon meeting prescribed integrity requirements to avoid their primary failure, which is likely to result in a hazardous engine effect.

(e) Engine Flight Cycle: The flight profile or combination of profiles upon which the approved life is based.

(f) Engineering Plan: A compilation of the assumptions, technical data and actions required to establish and maintain the life capability of an engine critical part. The Engineering Plan is established and executed as part of the pre- and post-certification activities.

(g) Life Management: A series of engineering, manufacturing and service support activities that ensure critical engine parts are removed from service prior to the development of a hazardous condition.

(h) Low Cycle Fatigue (LCF). The process of progressive and permanent local structural deterioration occurring in a material subject to cyclic variations, in stress and strain, of sufficient magnitude and number of repetitions.

(i) Manufacturing Plan: A compilation of the part specific manufacturing process constraints, which must be included in the manufacturing definition (drawings, procedures, specifications, etc.) of the engine critical part to ensure that it meets the design intent as defined by the Engineering Plan.

(j) Primary failure: Failure of a part, which is not the result of the prior failure of another part or system.

(k) Safe Life: A LCF to crack initiation based process where components are designed, manufactured, substantiated and maintained to have a specified service life, which is stated in operating cycles, operating hours or both. Crack initiation is defined as a fatigue crack of 0.030 inches in length by 0.015 inches in depth.

(l) Service Management Plan: A compilation of the processes for in-service maintenance and repair to ensure that an engine critical part achieves the design intent as defined by the Engineering Plan.

5. BACKGROUND

The failure of an engine critical part is likely to result in a hazardous engine effect as defined in section 33.75. In order to avoid these types of failures it is necessary to meet specific integrity requirements by executing a series of life management activities. The life management requirements as defined in section 33.14 necessitate the development and execution of an Engineering Plan, a Manufacturing Plan and a Service Management Plan. These three plans define a closed-loop system which link the assumptions made in the Engineering Plan to how the part is manufactured and maintained in service.

The Engineering Plan defines the assumptions, technical data and actions required to establish and maintain the life capability of the part. The Engineering Plan and the approved life are established prior to introduction of the product into service and updated as new information becomes available.

In order to develop and execute an Engineering Plan, it is necessary to have a consistent and repeatable manufacturing method, which is captured in the Manufacturing Plan. The Manufacturing Plan is a compilation of the manufacturing process steps, controls and constraints such as drawings, procedures, specifications, machining instructions, etc. required to produce a part using a controlled process that meets the design intent as defined by the Engineering Plan.

The Service Management Plan provides the same control aspects as the Manufacturing Plan, but ensures the operational service assumptions and life contained within the Engineering Plan remains valid.

These plans may generate limitations, which are published in the Airworthiness Limitation Section of the Instruction for Continued Airworthiness.

This AC provides guidance for the establishment and execution of these plans.

6. GENERAL

(a) Life System Approval
In order to utilize a lifing system, the system must be approved by the Authority.

(b) Identification of Engine Critical Parts
Engine critical parts are those parts that rely upon meeting prescribed integrity requirements to avoid their primary failure, which is likely to result in a hazardous engine effect. Typically, engine critical parts may include disks, spacers, hubs, shafts, high-pressure cases and non-redundant mount components.

If a part is made of various sub-parts, which are finally integrated in an inseparable manner into a unique part, and any one of the sub-parts is identified as an engine critical part, the entire part is then treated as an engine critical part.

(c) Attributes of a part
'Attributes' include, but are not limited to, material mechanical properties, material microstructure, material anomalies, residual stress, surface condition, and geometric tolerances. Processes such as alloy melting practice, ingot conversion to billet or bar, forging, casting, machining, welding, coating, shot peening, finishing, assembly, inspection, storage, repair, maintenance, and handling may influence the attributes of the finished part. Environmental conditions experienced in service may also affect the attributes.

(d) Content of a plan
The Engineering Plan, Manufacturing Plan and Service Management Plan should provide clear and unambiguous information for the management of the engine critical parts. 'Plan' in the context of this AC, does not necessarily mean having all required technical information contained in a single document. If the relevant information exists elsewhere, the plan may make reference to drawings, material specifications, process specifications, etc as appropriate. It should be noted that these references should be clear enough to uniquely identify the referenced document and to allow the history of the individual part number to be traced.

7. GUIDANCE FOR DEFINING AN ENGINEERING PLAN.

(a) Introduction
The Engineering Plan consists of comprehensive life assessment processes and technologies that ensure that each engine critical part can be withdrawn from service before hazardous engine effects can occur. These processes and technologies address the design, test validation, and certification aspects as well as define those manufacturing and field management processes and attributes that must be controlled in order to achieve the engine critical part design intent.

(b) Elements of the Engineering Plan

The Engineering Plan should address the following subjects:

- Analytical and empirical engineering processes applied to determine the approved life.

- Structured component and engine testing conducted to confirm engine internal operating conditions and to enhance confidence in the approved life.

- Establishment of the attributes to be provided and maintained for the manufacture and service management of engine critical parts.

- Development and certification testing, and service experience required to validate the adequacy of the design and approved life. Any in-service inspections identified as critical elements to the overall part integrity, should be incorporated into the Service Management Plan.

(c) Establishment of the Approved Life

Determining the life capability of an engine critical part involves the consideration of many separate factors, each of which may have a significant influence on the final results.

Typically the approved life is a fraction of the calculated minimum fatigue life because of the following factors:

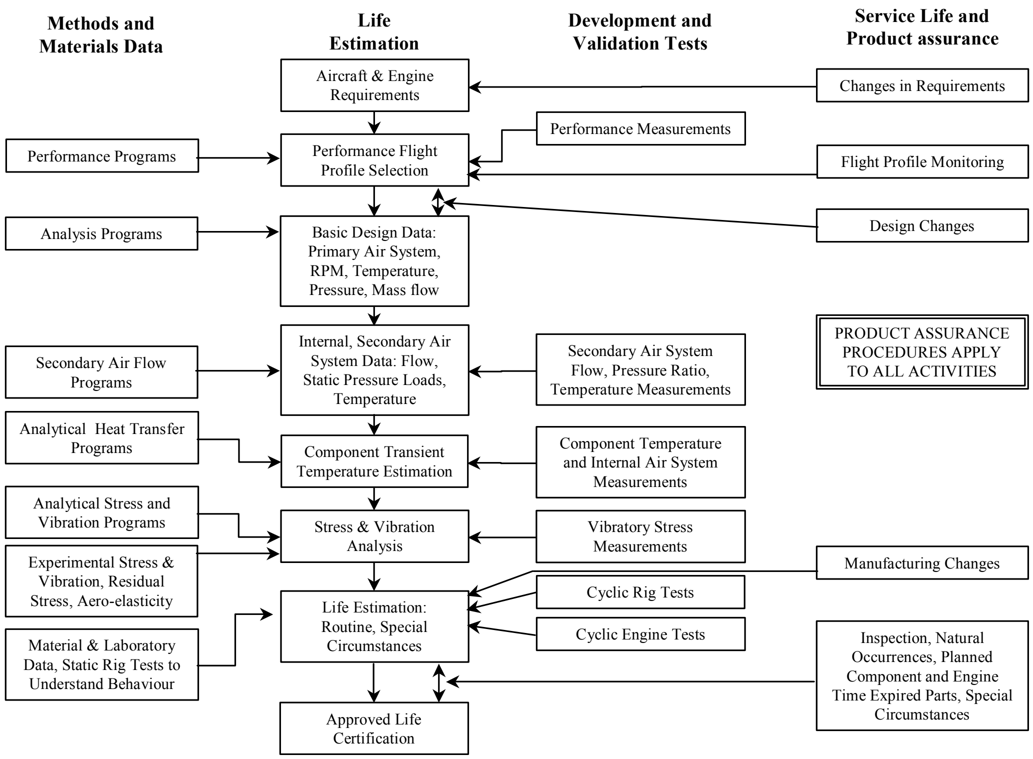
- Limitations of analytical capabilities in calculating cyclic life.

- Unknowns of field experience/service usage.

(i) Rotating Parts

The conventional gas turbine engine life management methodology (the "safe-life" method) consists of comprehensive processes and technologies related to the design, manufacture, test validation, certification and field management of high-energy rotors.

The following describes a typical process for establishing the approved life of rotating parts:



The major elements of the analysis are:

Operating Conditions.
For the purposes of certification, an appropriate flight profile or combination of profiles and the expected range of ambient conditions and operational variations will determine the predicted service environment. The engine flight cycle should include the various flight segments such as start, idle, takeoff, climb, cruise, approach, landing, reverse and shutdown. The hold times at the various flight segments should correspond to the limiting installation variables (aircraft weight, climb rates, etc.). A maximum severity cycle that is known to be conservative may be used as an alternative.

The corresponding rotor speeds, internal pressures, and temperatures during each flight segment should be adjusted to account for engine performance variation due to production tolerances and installation trim procedures, as well as engine deterioration that can be expected between heavy maintenance intervals. The range of ambient temperature and takeoff altitude conditions encountered during the engines' service life as well as the impact of cold and hot engine starts should also be considered.

The appropriateness of the engine flight cycle should be validated and maintained over the lifetime of the design. The extent of the validation is dependent upon the approach taken in the development of the engine flight cycle. For example, a conservative flight cycle where all the variables are placed at the most life damaging value would require minimum validation, whereas a flight cycle which more accurately represents some portion of the actual flight profile but is inherently less conservative, would require more extensive validation. Further refinements may be applied when significant field operation data are gathered.

Thermal analysis.
Analytical and empirical engineering processes are applied to determine the engine internal environment (temperatures, pressures, flows, etc.) from which the component steady state and transient temperatures are determined for the Engine Flight Cycle. The engine internal environment and the component temperatures should be correlated and verified experimentally during engine development testing.

Stress analysis.
The stress determination is used to identify the limiting locations such as bores, holes, changes in section, welds or attachment slots, and the limiting loading conditions. Analytical and empirical engineering processes are applied to determine the stress distribution for each part. The analyses evaluate the effects of engine speed, pressure, part temperature and thermal gradients at many discrete engine cycle conditions. From this, the part's cyclic stress history is constructed. All methods of stress analysis should be validated by experimental measurements.

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Life analysis.
A procedure should be developed which combines the stress, strain, temperature and material data to establish the life of the minimum property part. Plasticity and creep related effects should also be considered. Relevant service experience gained through a successful program of parts retirement or precautionary sampling inspections, or both, may be included to adjust the life prediction system.

The fatigue life prediction system is based upon test data obtained from cyclic testing of representative specimens and components and should account for the manufacturing processes that affect LCF, including fabrication from production grade material. Sufficient testing should be performed to evaluate the effects of elevated temperatures and hold times, as well as interaction with other material failure mechanisms such as high cycle fatigue (HCF) and creep. The fatigue life prediction system should also account for environmental effects, such as vibration and corrosion, and cumulative damage.

When the fatigue life is based on cyclic testing of specific parts, the test results should be corrected for inherent fatigue scatter. The factors used to account for scatter should be justified. In order to utilize this approach the test should be designed to be representative of the critical engine conditions in terms of the temperature and stress at the specific features, e.g. bore, rim or blade attachment details, of the part being tested. Appropriate analytical and empirical tools should be utilized such that the fatigue life can be adjusted for any differences between the engine conditions and cyclic test. In the event the test is terminated by burst or complete failure, crack initiation for this particular test may be defined using the appropriate crack growth calculations and/or fracture surface observations. It may also be possible to utilize the number of cycles at the last crack free inspection to define the crack initiation point. This approach requires an inspection technique with a high level of detection capability consistent with that used by the engine industry for rotating parts.

Test data should be reduced statistically in order to express the results in terms of minimum LCF capability (1/1000 or alternately -3 sigma). The fatigue life may be determined as a minimum life to initiation of a fatigue crack, defined typically as a crack length of 0.030 inch (0.75mm), but other methods may be used with the agreement of the Administrator.

Damage Tolerance Assessment.
Damage Tolerance assessments should be performed to minimize the potential for failure from material, manufacturing and service-induced anomalies within the approved life of the part. Service experience with gas turbine engines has demonstrated that material. manufacturing and service-induced anomalies do occur, which can potentially degrade the structural integrity of engine critical rotating parts. Historically, rotor life management methodology (safe-life method) has been founded on the assumption of the existence of nominal material variations and manufacturing conditions. Consequently, the methodology has not explicitly addressed the occurrence of such anomalies, although some level of tolerance to anomalies is implicitly built-in using design margins, factory and field inspections, etc. A damage tolerance assessment explicitly addresses the anomalous condition(s) and complements the fatigue life prediction system.

In the context of this rule, “appropriate Damage Tolerance assessments” recognizes that industry standards on suitable anomaly size and frequency distributions, and analysis techniques used in the damage tolerance assessment process are not available in every case. Where this is the case, compliance with the rule should be based on such considerations as design margins applied, application of damage tolerance design concepts, historical experience, crack growth rate comparisons to successful experience, etc.

An approach to the damage tolerance assessment process is contained within AC 33.14-1, which is applicable to material anomalies in Titanium alloy rotor components.

The damage tolerance assessment process typically includes the following primary elements:

- **Anomaly size and frequency distributions**.
A key input in the damage tolerance assessment is the size and rate of occurrence of the anomalies. This type of information may be statistical in nature and can be presented in a form that plots number of inclusions that exceed a particular size in a specified amount of material. Anomalies should be treated as sharp propagating cracks from the first stress cycle unless there is sufficient data to indicate otherwise.

- **Crack growth Analysis.**
This determines the number of cycles for a given anomaly to grow to a critical size. This prediction should be based upon knowledge of part stress, temperature, geometry, stress gradient, anomaly orientation, and material properties. The analysis approach should be validated against relevant test data.

- **Inspection techniques and intervals.**
Manufacturing and in-service inspections are an element of an overall strategy to address the fracture potential from inherent and induced anomalies. The interval for each in-service inspection should be identified. Engine removal rates and module and piece part availability data could serve as the basis for establishing the inspection interval. The manufacturing inspections assumed in the damage tolerance assessments should be incorporated into the Manufacturing Plan. Likewise, the assumed in-service inspection procedures and intervals should be integrated into the Service Management Plan and included, as appropriate, in the Airworthiness Limitations Section of the Instructions for Continued Airworthiness.

- **Inspection Probability of Detection (POD).**
The (POD) of the individual inspection processes, such as eddy-current, penetrant fluid or ultrasonic, used to detect potential anomalies should be based upon the statistical review of sufficient quantities of relevant testing or experience. The relevance of these data should be based upon the similarity of parameters such as:
  - Size, shape, orientation, location, and chemical or metallurgical character of the anomaly
  - Surface condition and cleanliness of the parts

- Material being inspected (such as its composition, grain size, conductivity, surface texture, etc.).
- Variation of inspection materials or equipment (such as the specific penetrant fluid and developer, equipment capability or condition, etc)
- Specific inspection process parameters such as scan index
- Inspector (such as visual acuity, attention span, training, etc.)

- **Material anomalies.**

Material anomalies consist of abnormal discontinuities or non-homogeneities introduced during the production of the input material or melting of the material. Some examples of material anomalies that should be considered are hard alpha anomalies in titanium, oxide/carbide (slag) stringers in nickel alloys, and ceramic particulate anomalies in powder metallurgy materials unintentionally generated during powder manufacturing.

- **Manufacturing anomalies.**

Limited industry standards are currently being developed for manufacturing anomalies. Until these are officially released and with the approval of the Authority, company specific and/or industry data should be used in the damage tolerance assessments.

Manufacturing anomalies include anomalies produced in the conversion of the ingot to billet and billet to forging steps as well as anomalies generated by the metal removal and finishing processes used during manufacture and/or repair. Examples of conversion related anomalies are forging laps and strain induced porosity. Some examples of metal removal related anomalies are tears due to broaching, arc burns from various sources and disturbed microstructure due to localized overheating of the machined surface.

- **Service-induced anomalies.**

Service-induced anomalies such as non-repaired nicks, dings and scratches, corrosion, etc should be considered. Similarity of hardware design, installation, exposure and maintenance practice should be used to determine relevance of the experience.

(ii) Static, pressure loaded parts

The general principles which are used to establish the Approved Life are similar to those used for rotating parts.

However, for static pressure loaded parts, the approved life may be based on the crack initiation life plus a portion of the residual crack growth life. The portion of residual life used should consider margin to burst. If the approved life includes reliance on the detection of cracks prior to reaching the approved life, the reliability of the crack detection should be considered. Any dependence upon crack detection should result in mandatory inspections being included in the Service Management Plan and in the Airworthiness Limitations Section (ALS) of the Instructions for Continued Airworthiness (ICA). Crack growth analysis techniques should be validated experimentally.

Some construction techniques, such as welding or casting, contain inherent anomalies. Such anomalies should be considered as part of the methodology to establish the approved life. Fracture mechanics is a common method for such assessments.

In determining the life of the part, the temperature of the part, any temperature gradients, and any significant vibratory or other loads (for instance, flight maneuver) should be taken into account in addition to the pressure loads.

Manufacturing and in-service inspections are an element of an overall strategy to address the fracture potential. The intervals for each specified in-service inspection should be identified. Engine removal rates and module and piece part availability data could serve as the basis for establishing the inspection interval. The manufacturing inspections should be incorporated into the Manufacturing Plan. Likewise, the assumed in-service inspection procedures and intervals should be integrated into the Service Management Plan and included, as appropriate, in the Airworthiness Limitations Section of the Instructions for Continued Airworthiness.

Tests

When using testing as part of the substantiation of the life of the part, the basic load cycle should be from substantially zero differential pressure to a value that simulates the most critical operation stress condition and returning to substantially zero differential pressure.

When a test is performed, the test pressure level should be adjusted to include the effects of stress due to thermal gradients in actual operation. When this is impossible, due to over-stress of regions other than the critical location or stress reversal in the Engine Flight Cycle for example, the fatigue capability in operation should be established by an additional analysis.

If the part is subject to loads in addition to those resulting from differential pressure (e.g. flight maneuver loads, engine mounting loads, etc.), an analysis should be made of these additional loads and their effect examined.

If the effect of these loads is small it may be possible to simulate them by an addition to the test pressure differential. However, if the loads are of significant magnitude or cannot adequately be represented by a pressure increment, the test should be carried out with such loads acting in addition to the pressure loads.

The part should be tested at the temperature associated with the most critical stress case or alternatively the test pressure differential may be increased to simulate the loss of relevant properties as a result of temperature.

Any fatigue scatter factors used should be justified.

During pressure testing the methods of mounting and restraint by the test facility or test equipment of any critical section should be such as to simulate the actual conditions occurring on the engine.

Analytical Modeling Methods
An analytical modeling method may be used to determine adequate fatigue life provided that the modelling method is validated by testing or successful field experience with parts of similar design.

(iii) Other Parts

For engine critical parts other than rotating parts or static pressure loaded components, a methodology for determining the approved life will need to be agreed with the Authority, using the general principles for rotating and static pressure loaded parts as a guideline.

(d) Maintaining the Approved Life

At certification, the approved life is based on predictions of engine operation, material behavior, environment etc. which all can be expected to influence the life at which the part must be withdrawn from service to avoid hazardous engine effects.

After certification it may be necessary to check the accuracy of such predictions, recognizing that many aspects, for example, the usage of the engine and its operating environment, may change during its operational life, especially with a change of ownership. It is important to use any service feed back to confirm that any assumptions made in the Engineering Plan remain valid, or are modified if required. The Engineering Plan should describe not only the basis of the approved life but also those actions subsequent to certification, which will be necessary to ensure that the approved life is appropriate throughout the operational life of the engine.

A regular review of the assumptions made when establishing the approved life may be required, depending on the conservative nature of the assumptions made when determining the approved life. The Engineering Plan should detail when such reviews should occur and what information will be required in order to complete the review.

Aspects which may be considered include, but need not be limited to:

- The frequency of approved life reviews
- Detailed inspection of service run parts, including time expired parts
- Review of flight plans
- Findings during maintenance
- Engine development experience
- Lessons learned from other engine projects
- Any service events

(e) Influencing Parts

Engine critical parts are part of a complex system and other parts of the engine can have an impact on the engine critical parts and their life capability. Therefore, the Engineering Plan needs to consider these parts, and particularly changes to them. Examples include, a new, heavier turbine blade, a new mating part with a different coefficient of thermal expansion, and a change to a static part, well upstream of an engine critical part that modifies the thermal environment around the engine critical part.

8. GUIDANCE FOR DEFINING A MANUFACTURING PLAN

(a) Introduction

The Manufacturing Plan is a portion of the overall integrity process intended to ensure the life capability of the part. The Engineering Plan includes assumptions about how engine critical parts are designed, manufactured, operated and maintained: each can have an impact on the part life capability. Therefore, it is essential to ensure that the attributes required by the Engineering Plan are maintained.

(b) Elements of a Manufacturing Plan

The part specific Manufacturing Plan should consider the Attributes of the part delivered by the manufacturing process from raw material to finished part and should highlight all sensitive parameters identified as being significant with regard to part life which should not be changed without proper verification. Such parameters may include, but may not be limited to: material controls, including any zoned areas for special properties, manufacturing method specifications, manufacturing method order of application, inspection method and sensitivity, and any special part rough machining methods or finishing method(s), especially any methods intended to improve fatigue capability or minimize induced anomalies.

(c) Development and Verification of the Manufacturing Plan

The Manufacturing Plan should be reviewed and verified by the following key Engineering and Manufacturing skills:

- Engineering (Design & Lifing)
- Material Engineering
- Non-Destructive Inspection
- Quality Assurance
- Manufacturing Engineering (Development & Production)

Hence, this same skill mix should evaluate and approve process validation and the rules for change control and non-conformance disposition to ensure that the product of manufacturing is consistent with the design assumptions of the Engineering Plan. The intent is that:

- Manufacturing processes are developed and applied with the appropriate level of oversight to ensure the part life capability assumed in the Engineering Plan is consistently achieved. Substantiation programs are agreed up-front and executed as part of the process validation.
- Changes to such manufacturing processes and practices are visible and are not made without cross-functional review and approval.
- When a suspected non-conformance event occurs, it is reviewed with the appropriate skill mix prior to disposition.

The level of detail in the Plan may vary depending on the specific process step being considered, the sensitivity of the particular process step, and the level of control required to achieve the required life capability.

For instance, consider the case where a process specification exists to control the drilling of holes. If the use of this specification produces a hole that meets the life capability requirements for a flange bolthole, the plan may simply note that the flange bolthole will be produced per the specification. However, if a rim air hole requires cold expansion, after drilling per the specification, to meet the life capability requirements, it may be necessary to reference the cold expansion process in the plan.

9. GUIDANCE FOR DEFINING A SERVICE MANAGEMENT PLAN

(a) Introduction

The Service Management Plan forms part of the overall process intended to maintain the integrity of engine critical parts throughout their service life. The Engineering Plan includes assumptions about the way in which the engine critical parts are manufactured, operated and maintained: each can have an impact on the life capability of the part. Therefore, it is essential to ensure that these assumptions remain valid. The Service Management Plan conveys the processes for in-service repair and maintenance to remain consistent with the assumptions made in the Engineering Plan.

(b) Determining the acceptability of repair and maintenance processes

Repair and maintenance processes should be reviewed by the following key skills:

- Engineering (Design & Lifing)
- Material Engineering
- Non-Destructive Inspection
- Quality Assurance
- Product Support Engineering
- Repair Development Engineering

The role of this cross-functional review is consistent with that laid out for the Manufacturing Plan. The review should include process validation, change control and non-conformance to ensure the product of any repair or maintenance is consistent with the engineering requirement. The intent is that:

- Repair and maintenance processes and practices are developed with the appropriate level of oversight, and with due regard to their possible impact on the life capability of the part. Substantiation programs are agreed up-front and executed as part of the validation process.
- Changes to such processes and practices are visible to all parties, and are not made without cross-functional review and approval.

- When a suspected non-conformance event occurs, it is reviewed with the appropriate skill mix prior to disposition.

To achieve the necessary control of the application of those processes and practices, the procedures for repair and maintenance should be clearly articulated in the appropriate section(s) of the engine shop manual. These procedures should also include clearly delineated limits to these processes and practices that will ensure that engine critical parts maintain attributes consistent with those assumed in the Engineering Plan**.**

(c) Service Management Aspects of Static Pressure Loaded Parts or Other Parts

The difference in approach to lifing for static pressure loaded parts or other parts means that in addition to the approved life, Instructions for Continued Airworthiness may typically contain:

- A defined periodic inspection interval in the ALS.
- The inspection method(s) to be used.
- A detailed description of the area(s) to be inspected.
- Inspection result acceptability limits.
- Acceptable repair methods, if applicable.
- Any other instructions necessary to carry out the required inspection and allowable maintenance procedures.

10. AIRWORTHINESS LIMITATION SECTION

(a) Repair and maintenance of engine critical parts

To ensure a closed-loop between the in-service parts and the Engineering Plan, the importance of the limits to the repair and maintenance of engine critical parts should be highlighted in the engine shop manual. Further, since inappropriate repair or maintenance could impact the integrity of the part in a hazardous manner, visibility should be provided through the Airworthiness Limitations Section (ALS) of Instructions for Continued Airworthiness. Wording as, or similar to, that shown below should be placed in the appropriate section of the ALS.

"The following airworthiness limitations have been substantiated based on engineering analysis that assumes this product will be operated and maintained using the procedures and inspections provided in the Instructions for Continued

Airworthiness supplied with this product by the Type Certificate holder, or its licensees. For engine critical parts and parts that influence engine critical parts, any repair, modification, or maintenance procedures not approved by the Type Certificate holder, or its licensees, or any substitution of such parts not supplied by the Type Certificate holder, or its licensees, may materially affect these limits. In such circumstances, appropriate airworthiness limitations should be obtained from the applicant responsible for the repair, modification, or substitute parts."

(b) OEI considerations

For rotorcraft engines desiring OEI ratings, the applicant should provide a method to account for the low cycle fatigue effects from the usage of the OEI ratings during the life of the engine. This may be accomplished by including in the ALS a method for adding a reasonable anticipated finite number of cycles to the expended life of the affected engine critical parts or by using appropriate life reduction factor(s) for each usage of the OEI power excursions.

[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 33

[Docket No. XXXXX; Notice No. XX-XXX]

RIN 2120-XXXX

Airworthiness Standards; Aircraft Engine Standards for Engine Critical Parts

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: The FAA proposes to amend the certification standards for original and amended type certificates for aircraft engines by modifying the standards for engine critical parts. The proposed rule would establish new and uniform standards for the design and tests of engine critical parts for aircraft engines certificated by the FAA and by the Joint Aviation Authorities (JAA).

DATE: Comments to be submitted on or before [insert date 90 days after the date of publication in the Federal Register].

ADDRESSES: Comments on this notice should be mailed, in triplicate to: Federal Aviation Administration, Office of the Chief Counsel, Attention: Rules Docket (AGC-200), Docket No.   , Room 915G, 800 Independence Avenue, SW, Washington, DC 20591. Comments submitted must be marked: "Docket No.   ." Comments may also be sent electronically to the following internet address: 9-NPRM-CMTS@faa.dot.gov.

Comments may be examined in Room 915G on weekdays, except Federal holidays, between 8:30 a.m. and 5:00 p.m.

FOR FURTHER INFORMATION CONTACT: Tim Mouzakis, Engine and Propeller Standards Staff, ANE-110, Engine and Propeller Directorate, Aircraft Certification Service, FAA, New England Region, 12 New England Executive Park, Burlington, Massachusetts 01803-5299; telephone (781) 238-7114; fax (781) 238-7199.

SUPPLEMENTARY INFORMATION:

Comments Invited

Interested persons are invited to submit written data, views, or arguments on this proposed rule. Comments relating to the environmental, energy, federalism, or economic impact that might result from adopting the proposals in this notice are also invited. Substantive comments should be accompanied by cost estimates. Comments must identify the regulatory docket number and be submitted in triplicate to the Rules Docket address specified above.

The Administrator will consider all comments received on or before the closing date before taking action on this proposed rulemaking. The proposals contained in this notice may be changed in light of comments received.

All comments received, as well as a report summarizing each substantive public contact with FAA personnel on this proposed rulemaking, will be filed in the docket. The docket is available for public inspection before and after the comment closing date.

Commenters wishing the FAA to acknowledge receipt of their comments submitted in response to this notice must include a pre-addressed, stamped postcard on which the following statement is made: "Comments to Docket No. ." The postcard will be date-stamped and mailed to the commenter.

Availability of NPRMs

An electronic copy of this document may be downloaded using a modem and suitable communications software from the FAA regulations section of the Fedworld electronic bulletin board service (telephone: 703-321-3339), the Federal Register's electronic bulletin board service (telephone: 202-512-1661), or the FAA's Aviation Rulemaking Advisory Committee Bulletin Board service (telephone: 800-322-2722 or 202-267-5948).

Internet users may reach the FAA's webpage at http://www.faa.gov/avr/arm/nprm/nprm.htm or the Federal Register's webpage at http://www.access.gpo.gov/su_docs/aces/aces140.html for access to recently published rulemaking documents.

Any person may obtain a copy of this NPRM by submitting a request to the Federal Aviation Administration, Office of Rulemaking, ARM-1, 800 Independence Avenue, SW, Washington, DC 20591, or by calling (202) 267-9680. Communications must identify the docket number of this NPRM.

Persons interested in being placed on the mailing list for future NPRMs should request, from the above office, a copy of Advisory Circular No. 11-2A, Notice of Proposed Rulemaking Distribution System, which describes the application procedure.

Background

Part 33 of Title 14 of the Code of Federal Regulations, (14 CFR part 33) prescribes airworthiness standards for original and amended type certificates for aircraft engines.

The Joint Aviation Requirements-Engines (JAR-E) prescribes corresponding airworthiness standards for the certification of aircraft engines by the Joint Aviation Authorities (JAA). While part 33 and JAR-E are similar, they differ in several respects. For applicants seeking certification under both part 33 and JAR-E, these differences result in additional costs and delays in the time required for certification.

The FAA is committed to undertaking and supporting the harmonization of part 33 and the JAR-E requirements. In August 1989, the FAA Engine and Propeller Directorate participated in a meeting with the JAA, the Aerospace Industries Association (AIA), and the European Association of Aerospace Industries (AECMA). The purpose of the meeting was to establish a philosophy, guidelines, and a working relationship for the resolution of issues identified as needing to be harmonized, including the identification of the need for new standards. All parties agreed to work in a partnership to jointly address the harmonization effort task. This partnership was later expanded to include the airworthiness authority of Canada, Transport Canada.

This proposal has been selected as an Aviation Rulemaking Advisory Committee (ARAC) project. This task was assigned to the Engine Harmonization Working Group (EHWG) of the Transport Airplane and Engine Issues Group (TAEIG) and notice of the task was published in the Federal Register on XXXX (XX FR XXXX). On XXXX, the TAEIG recommended to the FAA that it proceed with the rulemaking.

Service experience with gas turbine engines has demonstrated that material, manufacturing and service induced anomalies do occur. These anomalies can potentially degrade the structural integrity of high-energy rotors. Conventional rotor life methodology ("safe-life" method) typically determines the approved life based on the minimum number of cycles required to initiate a crack approximately .030 inches in length. The "safe-life" technique is founded on the assumption that rotor components are anomaly free (nominal condition). Consequently, the methodology does not explicitly address the occurrence of such anomalies, although some level of tolerance to anomalies is implicitly built-in using design margins, incorporating factory and field inspections, etc. Under nominal conditions, this safe-life methodology provides a structured process for the design and life management of high-energy rotors, which results in the assurance of structural integrity throughout the life of the rotor. Undetectable material processing, manufacturing and service-induced anomalies, therefore, represent a departure from the assumed nominal conditions.

In 1990, to quantify the extent of such occurrences the FAA requested that the Society of Automotive Engineers (SAE) reconvene the ad hoc committee on uncontained events. The statistics pertaining to uncontained rotor events are reported in the SAE committee report Nos. AIR 1537, AIR 4003, and SP-1270. While no adverse trends were identified, the committee expressed concern that the projected 5-percent increase in airline passenger traffic each year would lead to a noticeable increase in the number of aircraft accidents from uncontained rotor events which have the potential to cause catastrophic aircraft accidents. As a result of an accident in 1989, the root cause of which was traced back to a hard alpha anomaly in a titanium forging, the FAA requested the turbine engine manufacturers, through the Aerospace Industries Association (AIA), to review available techniques to determine if a damage tolerance approach could be introduced which, if appropriately implemented, could reduce the occurrence of uncontained rotor events. The industry-working group concluded that the technology was available to begin to implement enhancements to the conventional rotor life management process which would explicitly address anomalous conditions, although additional development and research would be required.

In response to accidents and incidents due to manufacturing induced anomalies in high energy rotating components, for example a fan disk rupture in 1996 which was traced to a severely worked material surface layer in one tierod bolt hole introduced during the machining of the hole in the disk, a report was developed by a partnership of the Aerospace Industries Association (AIA) Rotor Manufacturing Project Team (RoMan) and the Federal Aviation Administration (FAA). Industry data shows that about 25% of recent rotor cracking/failure events have been caused by post-forging manufacturing induced anomalies. This reinforced the need to conduct damage tolerance assessments and the need to have strong links between the Engineering assumptions and the Manufacturing processes.

Discussion of the proposed rule

Rotor disk fracture continues to be the major contributor to propulsion risk. The current dominating causes for turbine engine rotor disk failures are material, manufacturing and operationally induced anomalies (for example, improper repair, fretting, corrosion, etc.). While compliance with the current requirements has resulted in significant improvements in rotor uncontained failure rates, incorporation of recently developed technologies and methodologies is expected to provide further improvement.

Experience with a number of different types of static parts has demonstrated that fatigue failures have the potential to result in hazardous effects. For example, some high-pressure casing fatigue failures have resulted in uncontained high-energy fragments and fire. In addition, the operating pressures of engines continue to rise thus increasing this potential. In some instances, the Engine Certification Office (ECO) has requested engine manufacturers to evaluate the fatigue capabilities of engine static structures with the use of an "issue paper" under section 33.19(a) that requires the engine be designed and constructed to minimize the development of an unsafe condition between overhaul periods. Even so, engine case ruptures continue to contribute to propulsion risk. Based on the CAAM (Continued Airworthiness Assessment Methodologies) data, case ruptures is the tenth leading cause that results in a significant (CAAM level 3 or 4) hazard to the aircraft for turbofan engines installed on part 25 airplanes.

The term "engine critical parts" is being introduced to cover all parts, rotating and static, which rely on meeting prescribed integrity requirements to avoid their primary failure, which is likely to result in an hazardous engine effect. The current rules for control of engine critical parts are deficient in a number of areas:

- FAR's do not contain a concise and coherent rule for the overall control of critical rotating parts in terms of design, manufacture and service/maintenance.
- FAR's do not contain fatigue life and integrity requirements for static parts that meet the definition of an engine critical part
- FAR/JAR-E do not contain requirements to account for the potential degrading effects of material, manufacturing or service induced anomalies.

Harmonization of JAR-E 515 with FAR 33.14 was initiated to eliminate significant differences that had been identified and to improve these requirements as necessary (for example the introduction of damage tolerance). While the current part 33 and JAR-E requirements for "engine critical parts" are similar they differ in several aspects:

- FAR part 33 does not require the engineering assumptions to be linked to the manufacturing processes used to produce the part.
- FAR part 33 does not require the engineering assumptions to be linked to the maintenance processes used in service.

The proposed rule establishes explicit structural integrity requirements for engine critical parts, adopting the general intent of current JAR-E 515 for both static and rotating engine critical parts, and it has been harmonized with the proposed revision of JAR-E 515.

Industry experience was utilized to identify those considerations that need to be addressed. The new harmonized rule defines engine critical parts as those parts that rely on meeting prescribed integrity requirements to avoid their primary failure, which is likely to result in a hazardous engine effect. In the context of this proposed rule, hazardous engine effects are the conditions listed in part 33.75. As noted above, current FAR's do not contain fatigue life and integrity requirements for engine static parts yet some of these parts meet the definition of an engine critical part. The new harmonized rule addresses all parts, rotating or static, which meet the definition of an engine critical part. The integrity of engine critical parts shall be established by linking of the Engineering, Manufacturing and Service Management Plans.

Current FAR requirements for rotors specifically address low-cycle fatigue, with life limits (operating limitations) typically being based on crack initiation ("safe-life" method). The new harmonized rule, through the Engineering Plan, continues to address low cycle fatigue in the same manner as the existing rule, but also introduces requirements to conduct damage tolerance assessments to address the potential for failure from material, manufacturing and service-induced anomalies. The Engineering Plan is also required to address the continuing activities necessary to ensure that the approved life remains appropriate throughout the operational life of the engine. Engine critical parts are part of a complex system and other parts in the engine can influence the loads and environment to which they are subjected. Therefore, the Engineering Plan needs to consider these parts and changes to them. In addition, those attributes that are critical to the integrity of the part must be identified and controlled. In the context of this rule, attributes are inherent characteristics of the finished part that determine its capability.

The Manufacturing and Service Management Plans are developed to ensure that the attributes identified within the Engineering Plan are consistently manufactured and maintained throughout the lifetime of the part.

The general methods and approaches that are used to establish the approved lives for static engine critical parts are expected to be similar to those used for engine critical rotating parts. However, while life limits of engine critical rotating parts are typically based on the initiation of a crack ("safe-life"), experience with static parts has shown that the approved life for some of these components may use a portion of the crack growth life in addition to the crack initiation life.

The proposed harmonized FAR and JAR-E rules were developed by the EHWG and concurred with by the industry representatives who participated in the ARAC discussions of this proposal. The proposal will be included in both part 33 and JAR-E in an effort to harmonize US regulations with existing and proposed requirements of the JAA.

Paperwork Reduction Act

The Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)) requires that the FAA consider the impact of paperwork and other information collection burdens imposed on the public. We have determined that there are no new information collection requirements associated with this proposed rule.

Regulatory Evaluation Summary

Proposed changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 directs that each Federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic impact of regulatory changes on small entities. TO BE COMPLETED…

Regulatory Flexibility Determination

The Regulatory Flexibility Act (RFA) of 1980, as amended, establishes as a principle of regulatory issuance that agencies shall endeavor, consistent with the objective of the rule and of applicable statutes, to fit regulatory and informational requirements to the sale of the business, organizations, and governmental jurisdictions subject to regulation. To achieve that principle, the RFA requires agencies to solicit and consider flexible regulatory proposals and to explain the rationale for their actions. TO BE COMPLETED…

International Trade Impact

The Trade Agreement Act of 1979…. TO BE COMPLETED

Unfunded Mandates Reform Act

Title II of the Unfunded Mandates Reform Act of 1995 (the Act), enacted as Pub. L. 104-4 on March 22, 1995, requires each Federal agency, to the extent permitted by law, to prepare a written assessment of the effects of any Federal mandate in a proposed or final agency rule that may result in the expenditure by State, local, and tribal governments, in the aggregate, or by the private sector, of $100 million or more (adjusted annually for inflation) in any one year.

This proposal does not contain a Federal intergovernmental or private sector mandate that exceeds $100 million in any year; therefore the requirements of the act do not apply.

Executive Order 13132, Federalism

The FAA has analyzed this proposed rule under the principles and criteria of Executive Order 13132, Federalism. We determined that this action would not have a substantial direct effect on the States, on the relationship between the national Government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, we determined that this notice of proposed rulemaking would not have federalism implications.

Environmental Assessment

FAA Order 1050.1D defines FAA actions that may be categorically excluded from preparation of a National Environmental Policy Act (NEPA) environmental impact statement. In accordance with FAA Order 1050.1D, appendix 4, paragraph 4(j), this proposed rulemaking action qualifies for a categorical exclusion.

List of Subjects in 14 CFR Part 33

Air transportation, Aircraft, Aviation safety, Safety.

The Proposed Amendment

In consideration of the foregoing, the Federal Aviation Administration proposes to amend part 33 of Title 14 Code of Federal Regulations (14 CFR part 33) as follows:

PART 33 - AIRWORTHINESS STANDARDS: AIRCRAFT ENGINES

1. The authority citation for part 33 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701-44702, 44704

2. Revise §33.14 to read as follows:

§33.14 Engine critical parts.

Engine critical parts are those parts that rely upon meeting prescribed integrity requirements to avoid their primary failure, which is likely to result in a hazardous engine effect. Typically engine critical parts may include discs, spacers, hubs, shafts, high-pressure casings, and non-redundant mount components. For the purposes of this section, a hazardous engine effect is any of the conditions listed in section 33.75. The applicant shall establish the integrity of each engine critical part by:

(1) An Engineering Plan, the execution of which establishes and maintains that the combinations of loads, material properties, environmental influences and operating conditions, including the effects of parts influencing these parameters, are sufficiently well known or predictable, by validated analysis, test or service experience, in order to establish an approved life for each engine critical part. Appropriate damage tolerance assessments must be performed to address the potential for failure from material, manufacturing and service-induced anomalies within the approved life of the part. The procedures by which the approved life is determined must be approved by the Administrator. The approved life must be published as required by section 33.4.

(2) A Manufacturing Plan which identifies the specific manufacturing constraints necessary to consistently produce engine critical parts with the attributes required by the Engineering Plan.

(3) A Service Management Plan which defines in-service processes for maintenance and repair of engine critical parts which will maintain attributes consistent with those

required by the Engineering Plan. These processes shall become part of the Instructions for Continued Airworthiness.

Issued in Washington, DC, on

[Name of Office Director]
Director, Aircraft Certification Service

FAA Action – Not Available